

Psychology: the heritability of intelligence



One of the many popular controversies in psychology is the heritability of intelligence. While psychologists have sufficient reason to believe that the environment that an individual is exposed to plays the most important role in shaping his intellect, genetic engineers have repeatedly proven the role of genetics as being omnipotent. Despite extensive researches carried in both genetics as well as psychology over the past two centuries, concrete evidence describing the role of each has not yet been found. This paper seeks to answer the question that which among heredity and environment plays the more important role. The paper begins with an introduction to the concept of intelligence as a term to explain the cognitive brain. It explains the meaning of heredity and its association with intelligence. Then the perspective the intelligence with respect to the environment and heredity are elaborated. Finally, a conclusion to the findings is presented.

Introduction

The term intelligence can be defined as the capability of an individual to learn reason and understand his environment. The word intelligence is often accepted as a manifestation for high mental capacity. It is an accepted term to describe the mental capabilities of a human being in all its various forms.

According to Matlin(1996), the process of obtaining, storing, retrieving and utilizing knowledge is called intelligence. It expresses a collective capacity for survival and evolution beyond the present. All fundamental psychological processes like thinking, learning, reasoning, perception, decision-making, problem-solving, concept formation and memory are aspects of intelligence.

As a result, intelligent behavior involves all the numerous forms of conscious intellectual activity. In fact, of late, the horizons of the notion of intelligence have been broadened to include terms like “ emotional intelligence”, “ spiritual intelligence”, “ practical intelligence”, “ social intelligence”, “ vocational intelligence” and “ musical intelligence”.

According to Binet, intelligence is “ judgment or common sense, initiative, the ability to adapt oneself, to judge well, understand well, and reason well”. He stresses that “ intelligence is a capacity to enable the individual to take and maintain a definite direction, to make adaptations for attaining a desired goal and to be able to criticize oneself and others.”

Freeman defines intelligence as “ a capacity of successful adjustment in all sorts of situations.” Tests on the levels of intelligence lead us to this characterization. But this description is too broad. The theory of intelligence is more than the ability of adjustment.

According to Terman, “ intelligence is an ability to think in terms of abstract idea”. Although intelligence as an abstract idea is a noteworthy reflection, it barely covers the vast concept that intelligence is. As a result, this definition has also been criticized very much.

While dealing with abstract ideas comes easily for intelligent individuals, even objects and concrete jobs can be handled with equal success by them. It is the lack of a direction towards a useful goal that differentiates an intelligent person from another individual with limited intellectual capabilities.

Thorndike defined intelligence as the power of “ more association or connection forming ability”. However, this definition lacks precision. Connection-forming abilities can be present in a feeble-minded individual just as much as an intelligent one. Everyone can associate ideas to some extent.

Johnson characterized intelligence as an “ ability of solving the general run of problems of human beings, adjusting to new situations and being able to think.”

Rexknight defined intelligence, as “ Intelligence is the collective activity of individual human beings to act resolutely, think relationally and deal efficiently with the environment.”

In modern psychology, more value is given to the measurement of intelligence than the definition of it. This process of quantifying intelligence has led to a wider understanding of the concept of intelligence.

Many different techniques can be used to analyze human intelligence. There are many intelligence tests devised to judge the intelligence level of an individual. The score obtained from these tests is said to be the intelligence quotient or IQ of an individual. Therefore, today we have different tests based on visual, verbal and numerical abilities of an individual.

“ We cannot judge a fish based on its ability to climb a tree”

Hence, IQ tests are designed very accurately to check various types of skills in an individual.

Intelligence of an individual may vary across the following types: Linguistic intelligence, Logical- mathematical intelligence, spatial intelligence, Musical intelligence, Bodily-kinesthetic intelligence, Interpersonal intelligence, Intrapersonal intelligence.

The IQ of a person can be used to predict a person's educational achievement, job performance and income. They reflect an individual's intellectual capabilities and classify people into various levels of intelligence. IQ scores are a relative result, where mean IQ is said to be 100. Commonly, they vary between 55 and 160. An IQ of 55 is considered severely inadequate and an IQ of more than 160 is regarded as exceptionally gifted.

Heredity is the passing on of traits from parents to children. It is a process using which individuals acquire various characteristics from their parents. This process leads to the evolution of the species of human beings.

DNA strands in the cells of humans are known to be the carrier of genetic information. The complete set of observable traits of the structure and behavior of an organism is called its phenotype. These traits arise from the communication of its genotype with the environment.

The amount of changes in a trait depending on the genotype of a population living in a certain environment is said to be the heritability of that genotype. In order to understand the concept of heritability, a large number of factors must be taken into consideration. Heritability measures the dependence of the percentage of differences in a trait on genes. It does not measure the percentage of a trait caused by genes. Greater the heritability, lesser is the involvement of environmental factors.

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The question that this paper intends to answer is whether intelligence as a characteristic is hereditary or acquired. The paper wishes to explore the domains of intelligence and heredity to determine the primary actor behind an individual's intelligence quotient – the traits we inherit from our parents or the lessons learnt from the environment we grow up in.

The history of the psychological construct of intelligence

Around the end of the 19th century, the different schools of psychology were divided in the approach to measure mental processes. One of the early psychologists, Francis Galton viewed mental processes as a “black box”. A black box is an interface between the sensory input received and the motor output for that input. The mental processes were the black box, that is, they could not be directly observed. It was the job of the psychologist to observe the variations in the complexities of the sensory inputs and then observe the differences in the outputs. The relationships between these complexities of sensory inputs, the speed and accuracy of the response to these inputs were the rudimentary measures of intelligence.

These psychologists conceptualized the paradigm of response time. In order to measure the response time, an easy to understand task is given to a subject and he is expected to come up with the best solution. The time taken by the subject to process the sensory information with respect to the task and perform an appropriate motor response measures the variations in mental processes. This approach to intelligence is largely a variable associated with the speed of information processing.

Another tradition of intelligence and intelligence testing originated in the public school system of France. In the 1890s, Alfred Binet was commissioned by the French government to arrive at a simple and expedient way to distinguish those children who would profit from a public education from those who would not benefit from schooling. The eventual answer provided by Binet had two striking differences from those of Galton. First, Binet measured responses to practical, real-life problems instead of pure sensory stimuli. Second, Binet designed tasks of varying difficulty so only some children could perform certain tasks. So, greater the number of tasks that a child could successfully perform, the more he would benefit from public schooling.

Binet is credited to modern day intelligence testing. The modern construct of intelligence is defined by the fundamentals laid down by Binet. A broad range of academic skills like vocabulary, reading, comprehension, syllogisms etc must be covered by the content of the testing methodologies. The tests measure nothing beyond intellectual capabilities of an individual: sensory thresholds, emotional, social or practical problem-solving and occupational, vocational and interests problems are not a subject of these tests.

The answers to the questions in an IQ test must have definite right and wrong answers that are agreed upon by everyone. Also, the questions must span a wide variety of levels of difficulty. Every subject of a given age may find some tasks easier than the others.

The present-day intelligence tests that began with Henri Binet were deliberately constructed to predict scholastic outcome in the French public

school system. Psychometric knowledge has been applied iteratively on the items on these tests to refine them and expand their content far beyond the initial scales set by Binet.

Environment Perspective

According to J. Aljabber (2001), the environment that surrounds an individual plays one of the major roles in shaping his intellectual abilities. The effects that the environment may have are also varied. Some factors may affect the whole population while some may affect only individuals in certain groups.

Social and cultural backgrounds play a very vital role in the development of intelligence. Individual families differ from one another with respect to culture and traditions. These things contribute in shaping the intellect of a person. For example, most families are concerned about improving the achievements of their children in schools. This awareness and knowledge regarding the vitality of education is more often than not reflected in the child's performance at school as well as in life.

Singh says, " Each class of parents value schooling and educational success saw themselves as supporting and helping their children to achieve success at school."

Families that raise their children by teaching them the value of education are the ones that have children who obtain high IQ scores.

Conversely, there are families that emphasize primary and survival learning skills more than education by the medium of school. It is highly predictable that the children from such families obtain low IQ scores since they have

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never been provided with the encouragement or motivation to concentrate on education.

Bruner says, “ Intelligence depends on the incorporation of culture” (Bruner and Singh, 1996).

It is evident that opportunities and experiences of education are not equal among individuals and this greatly affects their intelligence quotient.

Additionally, factors that further affect intelligence levels are:

- (a) Social Variables including occupation, schooling, interventions, and family environment
- (b) Biological Variables including nutrition, lead, perinatal factors, and alcohol
- (c) Continuously rising test scores
- (d) Individual life experiences.

In addition to the above, there is reason to believe that environmental factors can cause cultural and ethnic differences among people. As a result of the history of discrimination prevailing in the environment, the minority groups comprise an overly large part of the lower social classes, and therefore cultural and ethnic differences in intelligence are really the differences among social classes only. This is because people in lower social classes grow up in a relatively destitute environment in terms of economic resources. Children growing up in such environments have issues such as:

Lack of learning resources

Not getting enough privacy for studying

Lack of assistance from parents or elders

Lack of good role models

Quality of schools not at par

Not getting enough motivation to excel intellectually

Some researchers have a dispute that the IQ tests are biased against such minority groups which grow up in an economically inferior environment and thus cause the superficial cultural and ethnic differences.

However, it is also observed that not all minority groups score lower than whites in IQ tests. Whites have lesser IQ scores than Asian Americans on an average, and they also show less in school performance. The only explanation for this could be the Asian American cultural values that are based on encouraging educational achievement.

Heredity Perspective

According to J. Aljabber (2001), the role of genes in human beings is far more important than in any other species. The process of transfer of chromosomes involves 50% of the mother's chromosomes and 50% of the father's chromosomes. An individual has 46 chromosomes in all. So he has 23 of his mother's traits and 23 of his father's. Every chromosome represents a specific trait and has a particular function. So it can be concluded that “

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There is no single gene for intelligence, personality, behaviour, or even height” (Scott, 1998). For example, a specific chromosome is responsible for eye color, and another one is responsible for hair color. Such traits have absolutely nothing to do with the environment. Genes are the only factors that characterize these traits.

However, the environment can be classified into Shared Environment and Non-Shared Environment (Hughes & Cutting, 1999). Each category of the environment may or may not have effects on an individual’s intelligence. One of the most common research methods to explore the distinction between environmental and genetic factors is Twin Studies (Scott, 1998). Twin studies are considered a reliable technique to estimate the influence of genes and environment on the intelligence of individuals.

Twin Studies

The development of certain parts of our brain is highly affected by genes. Scientists in the US and Finland have found that the parts most influenced are those that govern our cognitive ability. Therefore, these scientists have concluded that IQ is an inherited trait.

A twin study was conducted by Paul Thompson at the University of California at Los Angeles. His colleagues used MRI to scan the brains of 10 pairs of identical twins and 10 pairs of fraternal twins. It is a known fact that identical twins have identical genes, whereas fraternal twins share on average half their genes.

The research resulted in findings that suggested certain regions of the brain were highly heritable. These included language areas, known as Broca's and Wernicke's areas, and the frontal region, which, among other things, plays a huge role in cognition.

According to this research, these areas showed a 95 to 100 per cent correlation between one twin and the other in case of identical twins. This means that essentially they were the same.

The finding suggests that the environment of an individual which includes his own personal experiences, what he learned in life, who he knew played a negligible role in shaping their cognitive abilities.

There were already large reviews on the heritability of human cognitive ability differences from more than 25 years. The conclusions of these studies have not been overturned by more recent studies. In Nichols'12 review, a broad heritability (h^2) of about 0.44 was suggested by Nichols' own analysis of almost 3000 sets of 11th grade, same-sex twins from the National Merit Twin Study from years 1962 and 1965. The broad heritability of general intelligence can be estimated to about 0.7.

Recent biometrical studies have been aimed at more explicit questions. They typically involve path analyses to estimate genetic and environmental contributions using structural equation modelling procedures.

An analysis at the Western Reserve Twin Project of first to sixth grade twins suggested that, " Abilities may be differentially affected by genetic and environmental variation. However, these differential patterns may be simply

reflecting the degree to which specific abilities measure general intelligence”.

Another test conducted at the Wechsler Intelligence Scale for Children (WISC) and 17 ability measures were taken into consideration in another test battery. All the tests were influenced by genetic sources common to all tests. Certain genetic effects were found to be specific to domains of cognitive functioning such as verbal, spatial, perceptual speed, and memory functions.

The heritability of intelligence quotient was further inspected in a Dutch Twin Study that involved 194 pairs taking Raven’s Progressive Matrices at the age of 16. Raven’s Progressive Matrices is a test with a high g-loading of nonverbal reasoning. The heritability estimates for Full Scale IQ were 0.82, for Verbal IQ were 0.84 and for Performance IQ were 0.68. Shared environment had no significant effect. The conclusion of this test was that the factorial structure of the WAIS subtests causes individual differences in genetic structure.

A Dutch Twin Study analysed the changing genetic contribution with age. Twins were assessed by the RAKIT test battery at ages 5, 7, and 10 years and on the WISC-R at age 12 years. For full scale IQ (general intelligence), the contributions were as follows at ages 5, 7, 10, and 12 years: genetics, 26, 39, 54, 64; shared environment, 50, 30, 25, 21; and unique environment, 24, 31, 21, 15.

This decline in the contribution of shared environmental was in agreement with previous studies and augment in genetic influence from childhood to adolescence age was also in agreement with previous studies.

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Shared environment did not contribute to change in development but contributed to continuity and change in cognition, and unique environment contributed to change in development.

A curious twin analysis was held in the Scottish Mental Surveys of 1932 (572 pairs) and 1947 (517 pairs) involving a whole population cohort of 11-year-old twins who took part.

A Dutch study was conducted where several hundred adult subjects from extended twin families contained two cohorts, aged around 26 and 50 years were given a Dutch version of the Wechsler Adult Intelligence Scale III.

Verbal IQ had 85% variation and 69% of Performance IQ had 69% variation. The remainder was accounted for by non-shared environment. Shared environment did not show any significant effects. Four Wechsler cognitive domains for which the heritability was estimated were: verbal comprehension – 0.84; working of memory – 0.65; perceptual organisation – 0.68; and processing speed – 0.63.

The Colorado Adoption Project is A more recent analysis, The Colorado Adoption Project sought to find genetic and environmental influence pattern based on the stability of cognitive skills from early childhood through late adolescence. 245 adoptive and matched control families were there. At age 16 years children had taken cognitive tests (the WAIS).

The consistent relation between shorter reaction times and higher intelligence mainly appeared to reflect genetic effects shared by both measures. A wider range of information processing measures such as

inspection time, choice of reaction time, delay in the response speed and accuracy with IQ were studied by Luciano et al. The results indicated the presence of a general genetic cognitive factor affecting IQ and psychophysical phenotypes, as well as additional genetic factors explaining the additional test variance and covariance.

Environmental sources of variance were non-shared and mostly test-specific. An even larger sample of Australian and Dutch participants in an extended twin family design were taken into consideration for further study. Association between inspection time and IQ was investigated in that further study.

Research has proven that very low birth weight has negative effects on intellectual development. An association between IQ and normal variance in birth weight exists. Bivariate genetic analysis of this relationship in a longitudinal twin sample found a genetic mediation of birth weight and full IQ measured at ages 7 and 10 years, but not at ages 5 and 12 years. At age 16 years, the genetic variance in birth weight completely overlapped with that in verbal IQ but not performance or full IQ.

The evidence summarised above suggests that a maximum rate of progress in understanding the heritability of intelligence and the diverse range of cognitive differences can be achieved by large-scale studies of general ability among a group of people.

Racial heredity of intelligence

Interestingly, according to studies, there is also an incongruity in average IQ scores between whites and minority groups in the United States. Research has proved that Black, Native American, and Hispanic people score poorer, on average, than white people in standardized IQ tests. The reason for the existence of this difference is a controversial topic: whether this difference is due to heredity or environment.

Racial differences among individuals are also a result of genetic differences. Therefore, a study of variations of cognitive capabilities can also indicate the heritability of intelligence.

Richard Nisbett elaborates on the current difference in intelligence between blacks and whites by providing a commentary on Rushton and Jensen(2005).

Almost all tests for African American 12th graders when compared with other 12th graders over the period 1965-1994 suggested an improvement according to Hedges and Nowell (1998). The best estimates in terms of the stability the scores provide, and in terms of their correlations with IQ, are in the form of composites, for example, reading, vocabulary and mathematics. There was a decrease by 0.13 of standard deviation per decade in the Black-White gap on these composites over the period. Whites gained slightly in both math and reading between 1971 and 1996, but Blacks gained much more, narrowing the gap by 0.2 to 0.6 standard deviations. This would yield estimates of elimination of the gap somewhere between 20 and 60 years from now, except that the gains were concentrated among the students, at all age groups, who entered school in the period between 1968 and 1980. Students entering before that period and after that period showed no gains.

The gap is substantially less than that at the present time, probably more like 0.6-0.7 standard deviation or approximately 10 IQ points.

U. S. “ Black” populations contain as much as 30% European genes. This imply that an individual who is identified as Black could have anywhere from 100% African ancestry to mostly European ancestry.

Five different types of studies allow for an estimation of the effect of relatively African versus relatively European genes on IQ:

Skin colour

Lighter skin may be presumed to be associated with an individual having a higher IQ. This is because a more advantageous social and economic background can be assumed for those with lighter skin. These advantages are expected to reflect on their IQ.

Mixed-Race Children Born to Either a Black or a White Person

If the Black-White IQ gap is largely hereditary, then children having one black and one white parent should have the same IQ on average, regardless of which parent is Black. But if one assumes that mothers are particularly important to the intellectual socialization of their children and if the socialization practices of whites are more favourable to IQ development than those of black mothers, then children of White mothers and Black fathers should have higher IQs than children of Black mothers and White fathers. This could of course not have a plausible genetic explanation. In fact, it emerges that children of White mothers and Black fathers have IQs 9 points higher than children with Black mothers and White fathers

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Self-Reports of European Ancestry

Another way to determine the genetic origins of the Black-White difference is to examine the tails of the distribution of Black IQ. We can ask whether Blacks having a significant degree of European heritage are more likely to have high IQ scores. The extreme high-end tail of the IQ distribution should be especially telling, because on the hereditarian theory one would expect people at the tail to be particularly likely to have substantial European ancestry. Degree of European ancestry was assessed on the basis of self-reports about parents and grandparents. Children with IQs of 125 or above, as well as those with IQs of 140 or above, were slightly less likely to have substantial European ancestry than was estimated to be characteristic of the U. S. Black population as a whole at the time.

Adoption Studies

Assignment of Black Adoptees to Families of Different Races

Under the hereditarian model, it should make relatively little difference whether Black children are adopted by Black families or by White families. Under an environmental model that assumes that White families are especially likely to intervene in their children's socialization in ways that result in their having high IQs, it should make a substantial difference whether the Black child is raised with a Black or White family. And in fact, it does. Black children raised by Black middle-class families had mean IQs of 104, whereas Black children raised by White middle-class families had mean IQs of 117. Though it is possible that self-selection of some kind might have operated to produce this difference, it could only have happened if

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genotypically less intelligent children were more likely to be assigned to the Black families than to the White families.

Assignment of Black and White Adoptees to the Same Environment

At age 4 or 5, the White children had IQs of 103, the Black children IQs of 108, and mixed-race children IQs of 106. The Black children were West Indian and the White children were English, and though it is possible that the Black children were born to more intelligent parents than the White children

Assignment of Black and White Adoptees to Different White Families

White families who had two White biological parents, two Black biological parents, or one Black and one White parent. The study is more difficult to interpret than the other two, one of which assigns Black children, who were probably equivalent in expected IQ, to either Black or White middle-class families and the other of which assigns both Black and White children to the same environment. The average IQ of the White children at age 7 to 8 years was 112, that of mixed-race children 109, and that of Black children 97. The results are consistent with the assumption that the middle-class family environment resulted in a substantial gain in IQ for all groups. They do not rule out a genetic contribution to explain the gap because the Black children had lower IQs than those of either of the other two groups. Because of the likelihood that the Black children had lower IQs to begin with, for both genetic and nongenetic reasons, however, the results do not give strong support to the hereditarian model. At age 17 the White children had IQs (as measured by another test) of 106, the mixed-race children 99, and the Black children 89. These results are not materially different, in terms of size of the

gap, from those at age 7 to 8. The Black children at the earlier point had IQs 15 points lower than those of the White children and at the later point had IQs 17 points lower. The gap was 3 points at age 7 to 8 between White children and mixed-race children and 7 points at age 17.

IQ can change

It seems that there is convincing evidence that IQ scores can increase. Mostly black families were involved in the intervention programme, which began at birth and continued until the children started school. Half of the mothers received job training and were sent to school so as to improve the children's environment. When the children started school, the 'experimental group' had an average IQ of 120.7 whereas the control group's average was 87.2 (an IQ score of 100 is average with a standard deviation of 10-15 points). Over time, these scores closed in on each other. At age 10, they were 104 and 86 respectively and at age 12-14, they were 100 and 90 respectively. These IQ scores reflect the average of the lower levels of the city of Milwaukee, which indicates that the environment can be attributed to a change in IQ. The results were promising since it seemed that we are not necessarily determined e. g. by being born into the lower classes of society and that under the right conditions, considerable changes can be observed; thus, the results clearly supported malleability of intelligence measured as IQ.

Intervention programmes have produced considerable IQ gains but have also produced considerable losses because there was no attempt to stimulate further after ending the programmes. It is indisputable, though, that the

results of the programmes support malleability of IQ because there was a change in the IQ scores. The same can be said about the subsequent decrease in IQ scores; it supports the idea that IQ is malleable. problem with the rise in IQ scores is the belief that there has been a complete ' failure' to increase IQ.

Conclusion

Having explored the domains of heredity and intelligence in great detail, it feels safe to conclude that both genes as well as environment have significant roles in shaping the intellect of an individual. Our genetics are handed down to us through generations and there is no way the effect of our genes can be nullified. The chromosomes that we acquire from our parents contain the key to our vital characteristics including our intelligence quotient. The various studies conducted on twins, adopted children as well as different races of humans give us enough evidence to prove the vital role played by heredity in influencing the cognitive mind. However, genetics is definitely not the only thing responsible for our intelligence. The environment that we live in, the cultural values that are instilled in us right from our childhood also have a very imperative part in affecting our IQ scores. The encouragement and enthusiasm shared by the family with respect to education and cognitive thinking as opposed to survival skills affect the ability of an individual to think, to reason and to make decisions. In conclusion, both genes as well as proper nurturing are equally important and responsible in building the intelligence quotient of an individual.